Remarks

In the Final Office action of November 24, 2010 claims 1-18 and 20 (all pending claims) were rejected under 35 U.S.C. § 103(a) as being unpatentable over Lee et al. (US 2004/0151171 A1) in view of Ovadia et al. (US 7,266,295 B2), Ohba et al. (US 6,101,193) and Ge et al. (US 6,819,870 B1). Claims 1-18 and 20 are now cancelled. Pending claims are 22-39.

The Office action attempts to combine the distinct teachings of four documents in order to make a case for obviousness, the number of references needing to be combined being itself an indicator of possible nonobviousness. Still, even combining all four of these referenced documents, the claimed invention is fundamentally different from the combination. The patent to Ovadia et al. is the new reference added to those cited in the previous Office action. Applicant's comments made in the prior response regarding the three already cited references of Lee et al. Ohba, and Ge et al. continue to apply and are reasserted. The Ovadia patent that is newly brought into the argument teaches synchronous slotted systems, while the claimed invention instead addresses asynchronous systems.

Lee et al. describes an optical router having N input ports and N output ports (Fig. 2 and par. [0037], lines 3-6) where the inputs and outputs are wavelength division multiplexed (par. [0033], lines 1-6). A controller and scheduler of the router, upon receiving an output request, checks whether a available wavelength channel exists, and if not the data from units in a buffer (par. [0060], lines 19-24). However, Lee does not teach that the buffer unit has electronic variable delays, is "adjustable from below to above the duration of a packet", nor that the "predefined number" of vacant wavelengths are greater than one. Ohba teaches classifying data packets by their packet length, thereby improving the fairness characteristics of the network by suppressing the burstiness of data traffic. (col. 8, line 62 – col. 9, line 11) Ge et al. describes a system (col. 3, lines 34-37; col. 5, lines 26-36; col. 8, lines 6-23) for sorting packets according to length before scheduling these packets onto a wavelength. The system will try to schedule the shortest packet first. If only a single wavelength is vacant, the packet will be scheduled to a fiber delay line (FDL) and then processed at the output of the FDL. The differences between Ge et al. and the present invention have been previously pointed out.

The newly cited Ovadia patent teaches that queued packets of an optical network can be transferred in time-slots, where a time-slot of fixed or variable length is allocated for reserving a bandwidth. The time-slot can be present at one wavelength or spread over several wavelengths. Ovadia's system is time-slotted with periodic time-division-multiplexed (TDM) channels (col. 5, lines 32-35), i.e., is synchronous. Because the system is a slotted system, the time when the time-slot for a specific TDM channel becomes available is predetermined. That is, it is predetermined when one or more wavelengths are vacant. In contrast, our present claimed system is asynchronous and it is therefore not predetermined when wavelengths become available. Furthermore, because Ovadia employs a time-slot allocatioan for reserving bandwidth (Ovadia, col. 5, lines 18-19), a burst of data is scheduled across a predetermined and fixed number of vacant wavelengths. This kind of scheduled event occurs periodically at predetermined times. In contrast, in our asynchronous system, rather than Ovadia's fixed number of wavelengths, there must be a defined minimum number of vacant wavelengths before any packet is scheduled. Because of the asynchronous network, in our system scheduling occurs at random times, rather than at Ovadia's predetermined time slots, and the actual number of vacant wavelengths employed may be higher than the defined minimum, rather than fixed. Hence, the mechanism applied by Ovadia is not applicable in our system, even in combination with any one or more of the other cited teachings, because Ovadia's mechanism is based on knowing in advance exactly how many wavelengths become available and exactly when they become available, as these happen periodically in Ovadia's time slotted system. Instead, our system applies continuous monitoring of the number of vacant wavelengths, since it is not known in advance in our asynchronous system when wavelengths will become available.

It is asserted in the Office action that Ovadia's expression "where the reserved time slots can be fixed duration or variable duration" is equivalent to our recited "have electronic variable delays". However, Ovadia never mentions any electronic variable delays, nor are variable delays required for Ovadia to implement variable length time-slots. In Ovadia, varying the length of a time-slot enables the functionality of allocating a TDM channel bandwidth according to the length of the time-slot (Ovadia, col. 5, line 26). The variable duration TDM channels (time-slots) are still transmitted periodically in Ovadia's synchronous system, and because the time-slots occur periodically (Ovadia, col.

5, lines 32-35), delays between the scheduling of bursts are fixed, not variable, in Ovadia's system.

The present claimed optical switch is patentably distinct from the combined teachings of all four cited documents. Together the four references do not reach the present claimed invention.

New independent claims 22 and 31 distinguish over the prior art.

Lee et al. does not disclose a switch arranged to determine the number of vacant output wavelengths for the destination, as claimed in claim 22. Nor does Lee et al. disclose scheduling a data packet from a queue only when at least a minimum number, greater than one, of output wavelengths for the destination are vacant.

Rather, Lee et al. teaches that the scheduler 155 checks the state of an output wavelength channel to confirm if an available channel exists, and "If there is an available channel, the data frame filled in the buffer is switched to the optical transmitting section" (paragraph 0060). Thus, in Lee et al., data is transmitted as long as a single output wavelength is available. This is very different from the present invention, in which a data packet from a queue is scheduled only when at least a minimum number greater than one (i.e. at least two or more) output wavelengths for the destination are vacant.

By delaying the scheduling of those packets that are buffered in the switch until at least a minimum number, being two or more, of output wavelengths are vacant, the present invention can improve packet-loss rates. It achieves this by lowering the probability that, when a packet is being scheduled out of a buffer queue, it contends with another, such as a later-received packet that is passing through the switch for the same destination. The greater the number of vacant wavelengths that are specified before a packet can be scheduled from a queue, the lower the probably of contention. This advantageous idea of only scheduling a buffered packet once more than one wavelength is vacant is not known from any of the cited documents.

The embodiments described in column 5, lines 15-41 of Ovadia et al. relate to synchronous scheduling using reserved time slots. The use of time slots in Ovadia et al. means that bandwidth on a specific optical channel is already reserved and scheduling is therefore predictable. Contingency-based scheduling is thus unnecessary and inappropriate. The teaching of Ovadia et al. is not therefore relevant to the contingency-based approach of Lee et al.

Even if Ovadia et al. were to be combined with Lee et al., Ovadia et al. would not supply the features of claim 22 which are missing from Lee et al. Specifically, Ovadia et al. also does not teach determining the number of vacant output wavelengths for a destination, and does not teach only scheduled a data packet when at least two or, more output wavelengths are vacant. Such contingency-based scheduling has no relevance to the time-slotted embodiments taught in Ovadia et al.

Neither Ohba nor Ge et al. teaches an optical switch arranged to determine the number of vacant output wavelengths for a destination; and schedule a data packet from a queue only when at least a minimum number, greater than one, of output wavelengths for the destination are vacant, as in claim 22.

Ohba does not even teach an optical switch, and is therefore in a different field of endeavor from the other cited documents and the prior art. One skilled in the art would not therefore combine its teaching with that of Lee et al., Ovadia et al. or Ge et al.

Claim 22 is therefore novel and inventive over the prior art.

Method claim 31 corresponds to claim 22 and is novel and inventive for at least the reasons set out above.

Regarding claim 23, none of the cited prior art teaches or suggests an optical switch arranged to schedule a data packet from a queue only when at least a minimum number of output wavelengths for the packet's destination are vacant, wherein the minimum number of output wavelengths is smaller for a queue associated with relatively-short data packets than it is for a queue associated with relatively-long data packets.

Longer data packets will necessary take longer to output from the switch than will shorter packets. They therefore have a higher inherent probability of conflicting with another packet when being scheduled. By applying a higher minimum wavelength-vacancy requirement to such packets, this higher contention risk can, to some degree, be mitigated, leading to improved packet-loss rates. Such an advantageous arrangement is not known from the cited documents.

In particular, while Ohba discloses queues corresponding to different packet length ranges, this is in a quite different technical context from optical switches. They are not queues in an optical switch. Moreover, there is no suggestion in Ohba of associating

different minimum numbers of output wavelengths to the different queues, or of scheduling data packets only when at least the associated minimum number of output wavelengths for a destination are vacant.

Ge et al. discloses that "incoming packets are sorted in ascending order based on the data packet size, wherein the shortest length data packet is processed first" (col. 5, lines 31- 32). This is quite different from assigning received data packet to one of a plurality of queues, each associated with a respective range of data-packet lengths, as in claim 23. Furthermore, Ge et al. does not teach scheduling a data packet from a queue only when at least an associated minimum number of output wavelengths for its destination are vacant. On the contrary, Ge et al. simply processes the shortest data packet first, taking no account of the number of vacant output wavelengths for a destination.

Dependent claim 23 is novel and inventive in its own right. For at least the same reasons, corresponding dependent method claim 32 is also novel and inventive in its own right.

Conclusion

Reconsideration is requested in view of this Amendment and the remarks made herein. A telephone conference is requested to discuss any outstanding issues. A Notice of Allowance is respectfully requested.

You are authorized to charge any fee deficiency or credit any overpayment to Deposit Account No. 19-0590.

CERTIFICATE OF TRANSMISSION

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being transmitted via the Office electronic filing System in accordance with § 1.6(a)(4).

Signed: Sally Azevedo
Typed Name: Sally Azevedo

Date: May 23, 2011

Respectfully submitted,

Thomas Schneck

Thomas Schneck
Reg. No. 24,518

Schneck & Schneck
P.O. Box 2-E
San Jose, CA 95109-0005
(408) 297-9733